3-Neutrino Mixing Working Group Summary

Lisa Whitehead, Doug Cowen, Concha Gonzalez-Garcia

WINP

February 6, 2015

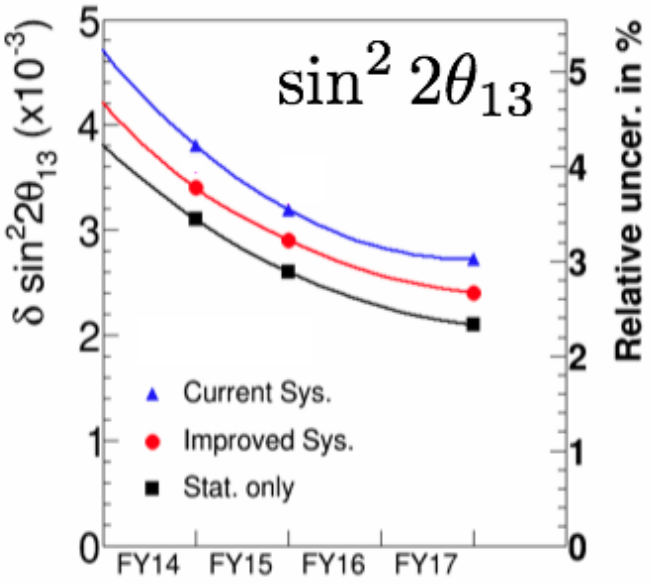
Focus of our Session

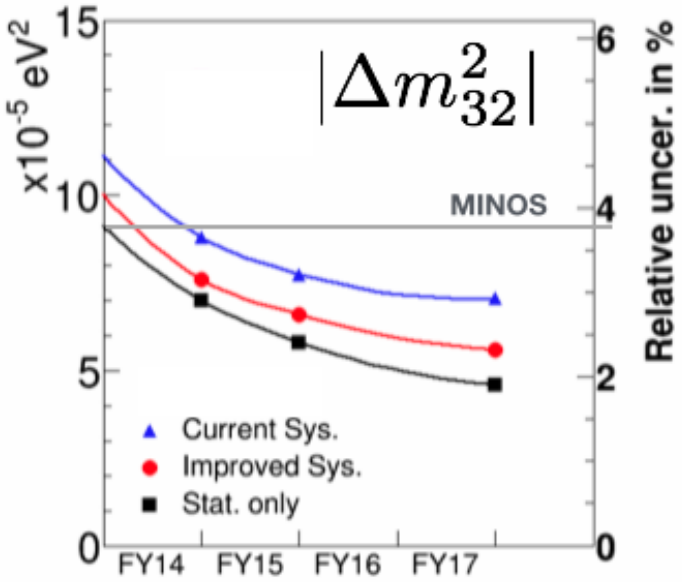
- Experiments trying to measure one or more of the three unknown oscillation parameters in the 3-neutrino mixing model
  - Mass ordering
  - δ_{CP}
  - θ_{23} octant
- Experiments contributing to the success of the measurements
  - Reduction of systematic uncertainties
  - Precision measurement of other oscillation parameters

Experiments Covered in Our Session

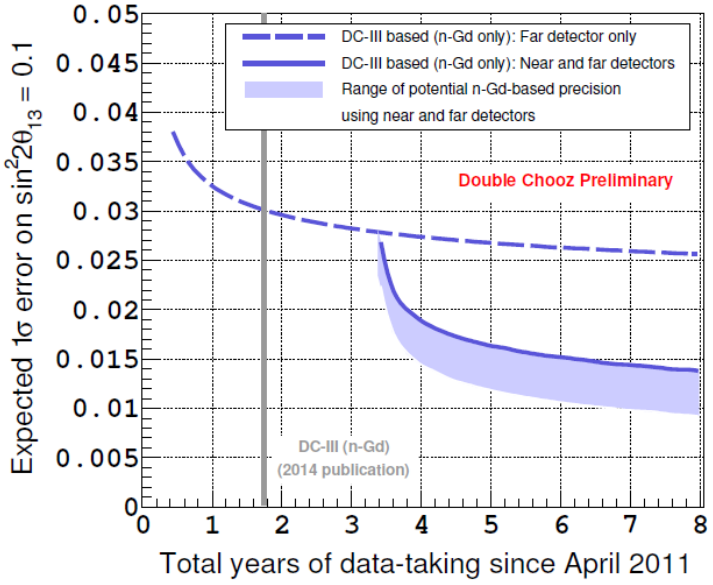
- Currently Running
  - Oscillation Measurements
    - Daya Bay (Steve Kettell)
    - Double Chooz (Rachel Carr)
    - T2K (Mike Wilking)
    - NOvA (Chris Backhouse)
    - MINOS+ (Will Flanagan)
    - Super-K (Michael Smy)
    - IceCUBE (Tyce DeYoung)
  - Systematics
    - MINERvA (Minerba Betancourt)
    - NA-61 (Geoff Mills)
- Proposed or under construction
  - Oscillation Measurements
    - JUNO (Steve Kettell)
    - Hyper-K (Michael Smy)
    - PINGU (Tyce DeYoung)
    - Theia (Bob Svoboda)
    - Daedalus (Jose Alonso)
    - LBNF (Michael Mooney)
  - Systematics
    - nuPRISM (Mike Wilking)
- Synergies (Patrick Huber)

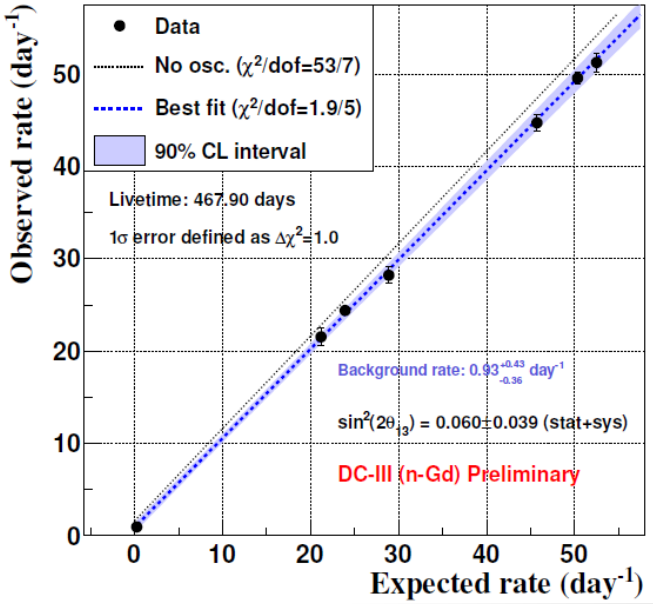
Daya Bay



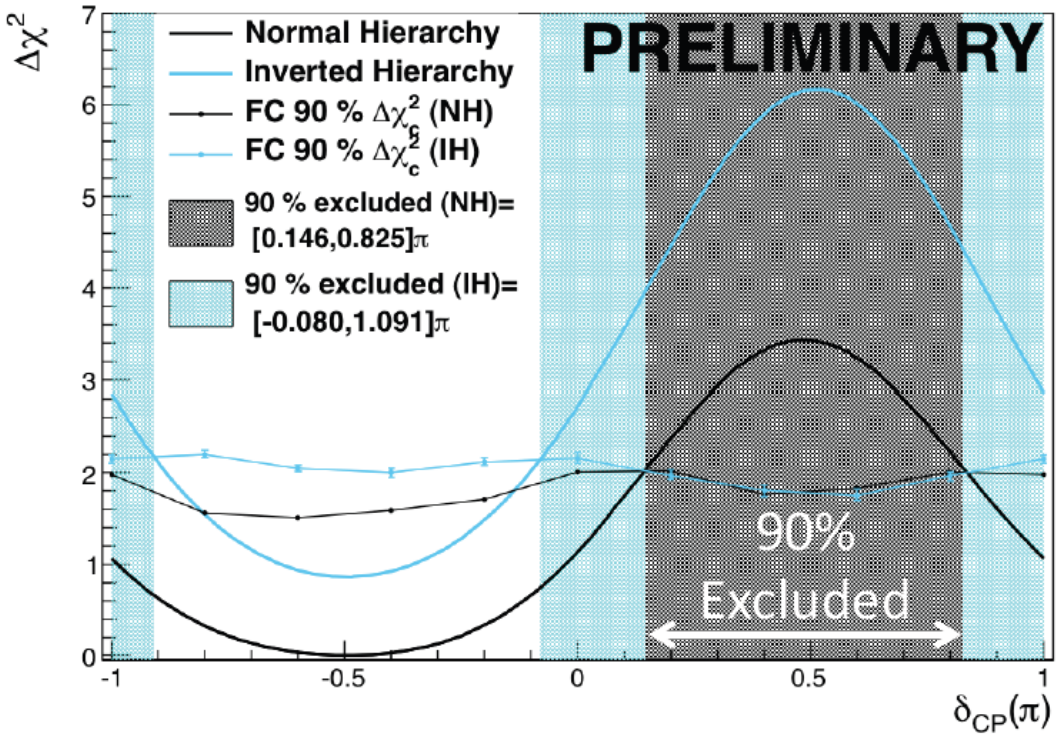


Current Program

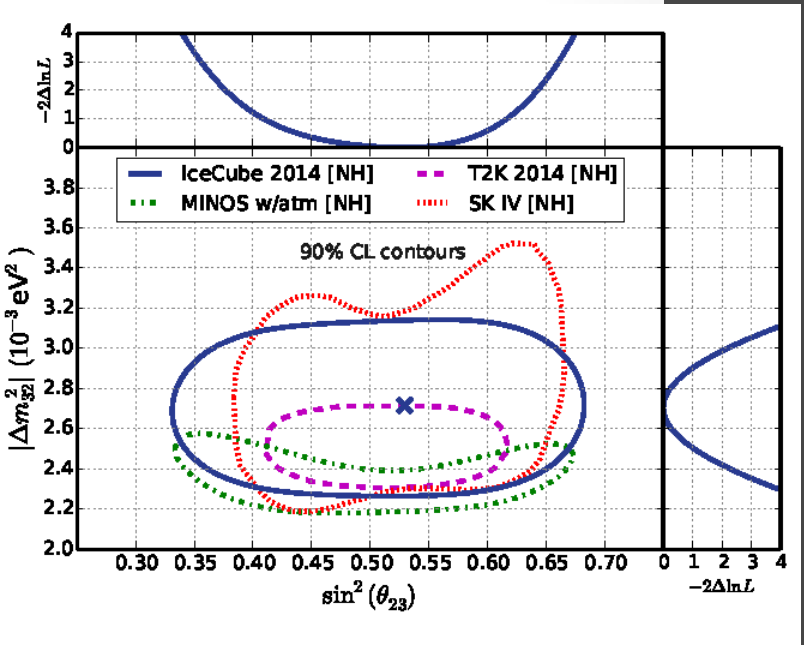




Double Chooz

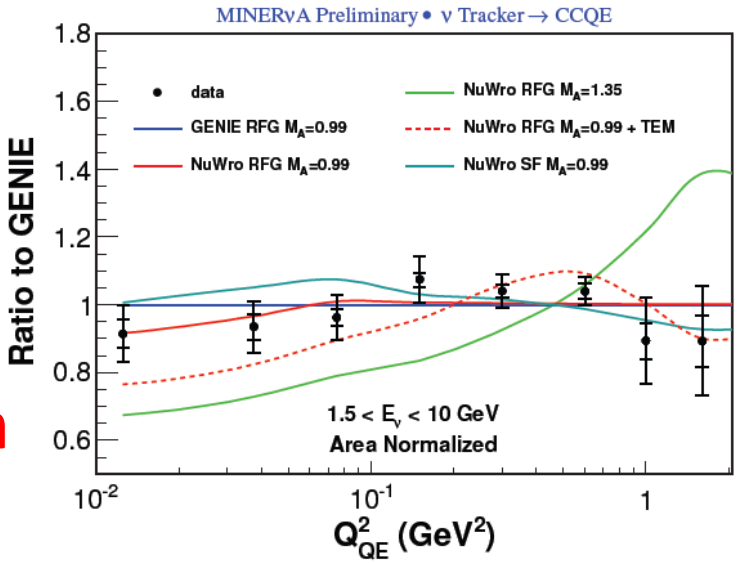


T2K (using Daya Bay best fit)

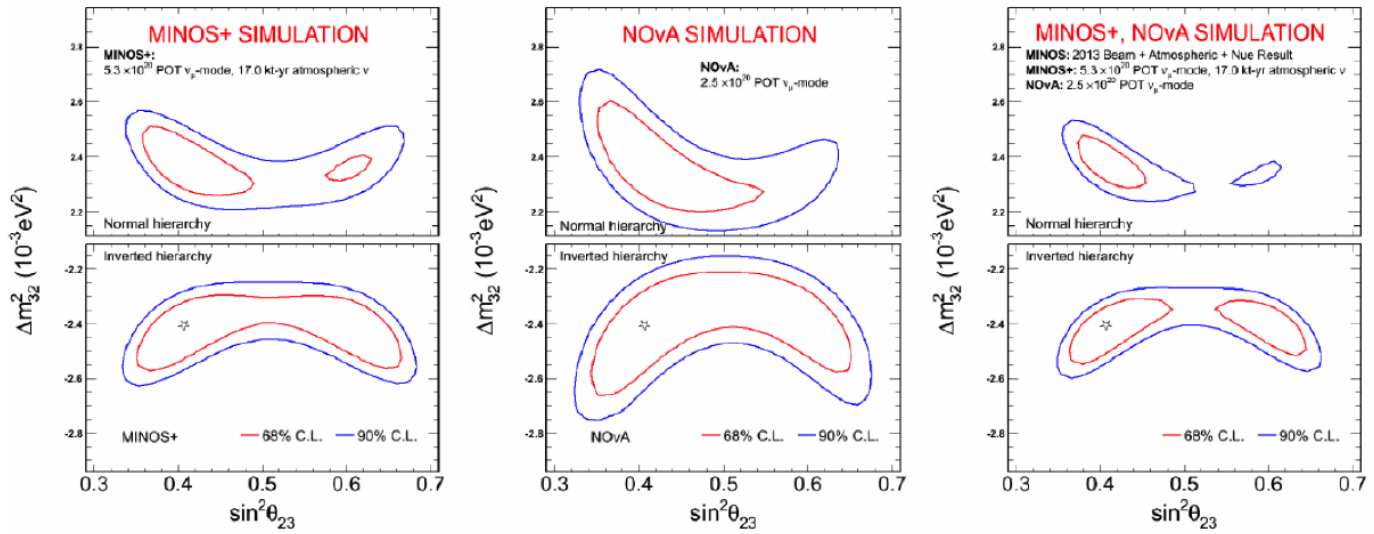


SK/T2K/MINOS/IceCube (arXiv:1410.7227)

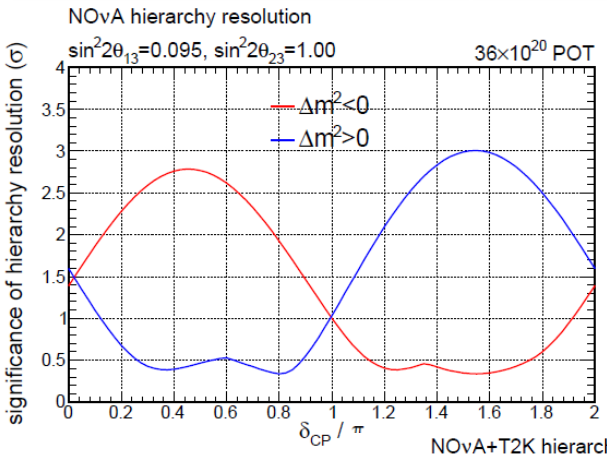
Current Program



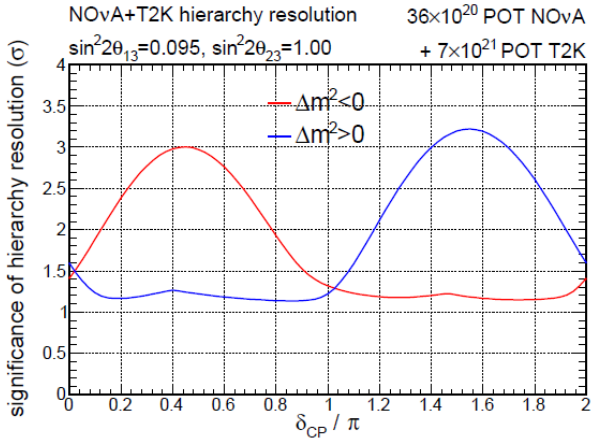
Phys. Rev. Lett. 111, 022501 (2013) MINERvA



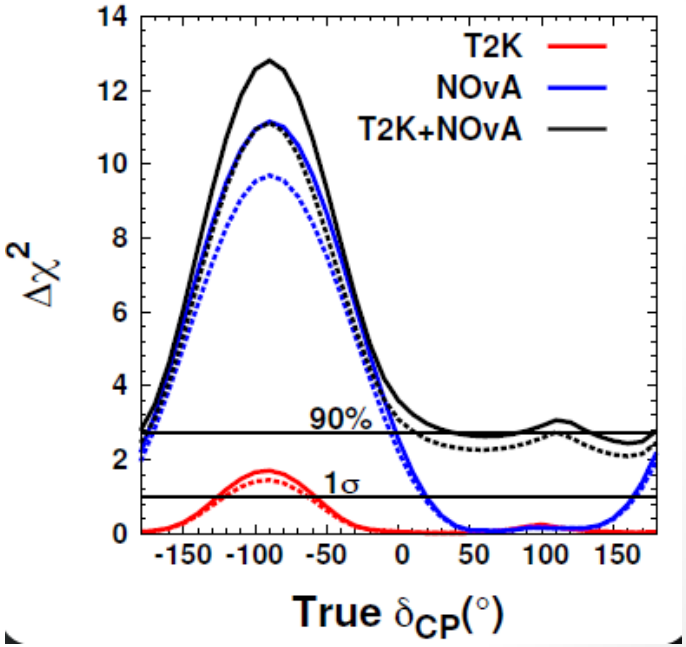
Early NOvA + MINOS/MINOS+



T2K + NOvA MH



Current Program



T2K + NOvA MH

The Current Program

- 3-neutrino mass and mixing is the only uncontroversial leptonic flavor structure coming out of the experimental results up to now.
- The still unknowns in this framework are: the ordering of the states and the possibility of leptonic CP violation. The non-maximality of θ_{23} also has to be clarified.
- The determination of these unknowns is of key importance to understand the mechanism responsible for neutrino masses as well as the possibility of generation of the matter-antimatter asymmetry in the early universe.
- The suite of presently running experiments are either directly exploring the three unknowns or are producing results that will directly contribute to these measurements by reducing systematic uncertainties (neutrino interaction measurements) or precisely measuring related parameters (θ_{13}, atmospheric mass splitting).
- Proposed and running experiments can potentially measure the ordering and θ_{23} octant in the next 5-10 years. The measurement of CPV is likely to take longer and require a large-scale experiment.

Proposals for the Intermediate Neutrino Program

- Proposals relevant to the 3-neutrino mixing program that are appropriate for new FOA
  - nuPRISM
  - CAPTAIN-MINERvA
  - Gd in Super-K
  - R&D for Theia
- And perhaps
  - Accelerator R&D (Daedalus) – does it fit within this FOA?
  - R&D towards US contribution to JUNO?

Suggested Guidelines for FOA

- Discovery potential
- Improve physics reach of other experiments
- Leverage existing resources
- Visible, significant US participation
- Low technical risk/familiar technology
- Each project should result in multiple theses
- Cost ~$1M each